



**ST. MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES**

**ASSESSING MAJOR CAUSES AND IMPACTS OF DESIGN
CHANGE: THE CASE OF BOLE INTERNATIONAL AIRPORT
EXPANSION PROJECT.**

By

**FREGENET ZEMEDKUN
ID: SGS/0108/2010B**

JANUARY, 2020
ADDIS ABABA, ETHIOPIA

**ASSESSING MAJOR CAUSES AND IMPACTS OF DESIGN
CHANGE: THE CASE OF BOLE INTERNATIONAL AIRPORT
EXPANSION PROJECT.**

**A THESIS SUBMITTED TO ST. MARY'S UNIVERSITY, SCHOOL OF
GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN
PROJECT MANAGEMENT (MA)**

Advisor: Tilaye Kassahun (PhD)

JANUARY, 2020

**SAINT MARY'S UNIVERSITY
SCHOOL OF GRADUATE STUDIES
PROJECT MANAGEMENT PROGRAM**

**ASSESSING MAJOR CAUSES AND IMPACTS OF DESIGN
CHANGE: THE CASE OF BOLE INTERNATIONAL AIRPORT
EXPANSION PROJECT.**

BY

FREGENET ZEMEDKUN

APPROVED BY BOARD OF EXAMINERS

_____ Dean, Graduate Studies	_____ Signature	_____ Date
_____ Advisor	_____ Signature	_____ Date
_____ Internal Examiner	_____ Signature	_____ Date
_____ External Examiner	_____ Signature	_____ Date

Table of Contents

Table of Contents	i
Acknowledgments.....	iv
List of Abbreviations	v
List of Tables	vi
List of Figures.....	vii
Abstract.....	viii
CHAPTER ONE- INTRODUCTION.....	1
1.1 Background of the Study	2
1.2 Statement of the Problem.....	2
1.3 Basic Research Questions	3
1.4 Objectives of the Study	3
1.4.1 General Objectives	3
1.4.2 Specific Objectives	4
1.5 Definition of Terms	4
1.6 Significance of the Study	4
1.7 Scope of the Study	4
1.8 Organization of the Thesis	5
CHAPTER TWO – REVIEW OF RELATED LITERATURE.....	6
2.1 Theoretical Review	6
2.1.1 Introduction.....	6
2.1.2 Basics of Building Design & construction Projects.....	6
2.1.2.1 Define Building Design	6
2.1.2.2 Building Design Stages.....	6
2.1.3.Design Change	8
2.1.3.1 Define Design Change	8
2.1.3.2 Causes of Design Change	8
2.1.3.2.1 Internal Factors	8
2.1.3.2.2 External Factors	10

2.1.4. Impacts of Design Change	11
2.1.5. The Ten Knowledge Areas	14
2.2 Empirical Review.....	16
2.2.1 Empirical Findings on Design Change	17
2.3 Summary of Findings of Literature Review	18
2.4 Conceptual Framework.....	18
CHAPTER THREE– RESEARCH METHODOLOGY.....	20
3.1 Research Design.....	20
3.2 Research Approach	20
3.3 Census Techniques.....	20
3.4 Source and Tools/Instruments of Data Collection	21
3.5 Methods of Data Analysis.....	22
CHAPTER FOUR– RESULTS AND DISCUSSION	23
4.1 Questionnaires Survey Response Rate.....	23
4.2 Demographic Characteristics of the Respondents.....	24
4.3 Results.....	25
4.3.1 Existence of Problem	25
4.3.2 Internal and External Causes of Design Changes	25
4.3.3 Major Impacts of Design Change	29
4.4 Major Findings and Discussion	30
4.4.1 Major Causes of Design Change Identified in This Research	31
4.4.2 Major Impacts of Design Change Identified in This Research.....	33
CHAPTER FIVE– CONCLUSION AND RECOMMENDATIONS.....	35
5.1 Conclusions	35
5.2 Recommendations.....	37
5.2.1 For Consultant/Design Firms	37

5.2.2. For Client/Owner	37
5.2.3. For Contractors	38
5.3 Limitation of the Study	38
REFERENCES.....	39
APPENDIX: RESEARCH QUESTIONNAIRE.....	42

Acknowledgements

First and foremost, I thank the Almighty Lord for making this work possible. My deepest gratitude goes to my Advisor, Tilaye Kassahun (PhD) for his critical professional comment, constructive criticism, regular follow up; suggestion and useful advice have been invaluable inputs that have improved the quality of my work.

Further, I would also like to thank all of those who helped me during the research by responding to my questionnaires and who assisted directly or indirectly to acquire the necessary data.

It gives me a great pleasure to take this special opportunity to express my sincere and warmest gratitude to my Father Zemedkun Geletu and my lovely Mother Genet G/Michael for contributing everything in my path, my sisters and brothers for unlimited support and their indispensable material and moral shore up in my graduate program.

Above all Glory is to God for his unspeakable gifts!

List of Abbreviations

ADPI – Aéroports de Paris International

EAE – Ethiopian Airports Enterprise

USD – United States Dollar

GDP – Gross Domestic Product

US – United State of America

UK – United Kingdom

R –Rank

MS –Mean Score

SPSS – Statistical Package for Social Sciences

List of Tables

Table 4.1.1: Questionnaire Survey Response Rates	35
Table 4.1.2: Demographic Characteristics of Respondent	36
Table 4.1.3: Educational Background & Work Experience of the Respondents.....	36
Table 4.3.1: Mean Scores and Ranks for Internal Causes of Design Changes.....	37
Table 4.3.2: Mean Scores and Ranks for External Causes of Design Changes	39
Table 4.3.3: Major causes of design change in Airport Expansion Projects	40
Table 4.3.4: Mean Score (MS) and Rank (R) for impact of design change	41

List of Figures

Figure 2.4.1: Conceptual Framework	30
Figure 4.1.1: Respondents Responses on Whether Design Change is a Problem or Not.....	36
Figure 4.1.2: Respondents Responses on Frequency of Design Change	36
Figure 4.3.2: Respondents Responses on More Responsible Parties/ Main Initiators	40
Figure 4.3.4: Respondents Responses on Most Affected Parties	41

ABSTRACT

Construction industry is a major player in economy of any countries by generating employment and prosperity to the nations. However many projects in developing countries experienced very low performance in terms of time and cost. One of the contributing factors to this low performance among others is design change. This is because design change can affect project cost and schedules. With this background, the Objective of this study is to find out the existence and frequency of design change, identify the causes of these design changes and their impact, which contracting party is the more responsible in initiating these design changes and which is most affected as a consequences of these causes. The study design was Descriptive. Mixed approach was used and both primary and secondary data were collected using a questionnaire which consists of 32 potential factors for the cause of design change, major impacts and other questions which enable to achieve the objectives of the research were developed. The study finds that Change requested by the owner, poor communication between responsible parties, owners fail to review document at the right time, incorrect/unclear information given by the owner at initial stage of design and lack of precise and rapid decision were identified as major causes which results these design changes and client/employer were identified more responsible in initiating most of the design change related issues. The study also finds; increase in project cost, delay of project, demolition & rework, decrease in quality of work and decrease in productivity parties as a major impacts and clients as the most affected contracting party as a result of impact of design change. Accordingly the study concludes that design change as one major problem in Airport Expansion projects.

Key Words:Change of design, Construction stage, Airport projects.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Construction plays a significant role in the overall economy of both developed and developing countries in terms of economic growth. Its various activities and related projects also have a great impact on different key factors of a country's overall development aspects (L. Ruddock, 2009). The construction industry has also impact on the rate of GDP and employment of many countries, and for this reason, the construction industry is considered to be important for the country's economic growth (Olawale, 2010). Hence, it is important for construction activities to be accomplished successfully in an effective and efficient way. A construction project is normally known as successful when it is completed on schedule, within budget, highest quality and in the safest manner, in agreement with the specifications and to stakeholders' satisfaction.

The construction industry is known as very large, complex, and requires huge capital investments. In Ethiopia, the construction industry is the highest heir of government budget in terms of government development program. However, Construction delays are going on in every stage of construction projects in Ethiopia and it is documented that the delays in construction projects are the main causes of project failure. According to Werku, et al., (2016), in Ethiopia only 8.25% projects have been finished to the original targeted completion date and the remaining 91.75% delayed 352% of its contractual time. Another study by Tekalign (2014) revealed that 79.06 % of the construction project fails to meet its objectives in Ethiopia and if completed it is with an average cost overrun of more than 26.2 %. As a result, the industry has been criticized extensively for poor performance and low productivity as well as dissatisfaction of the society at large.

There are many factors contributing to project delay and many researchers' findings revealed that design change is one of the factors for this setback. For instance, the research done by Kikwasi, G.J. (2012) which has been focused on assessing the causes and effects of delays and disruptions in construction projects in Tanzania described that, the design change was one of the major causes affecting performance and causing disruptions in construction projects in Tanzania.

Another study by Chang (2002) reported that cost increased on average of 24.8% and schedule increased on an average of 69% based on four sampled projects in California as a result of design changes. On the other hand, Chang, Shih, and Choo (2011) described that design changes has resulted in an increased in redesign cost of 2.1% to 21.5% and on average 8.5% of the construction change cost. A study by Shehu et al. (2014) conducted 359 samples of a questionnaire survey of Malaysian quantity-surveying consultants and reported that an alarming 55% of projects in Malaysia suffer from cost overruns. The most prominent concern related to design changes that happened in Malaysia is the construction of Kuala Lumpur International Airport 2 or known as KLIA2. The initial target date for opening was September 2011 but was later moved several times and finally completed in May 2014. The construction cost ballooned from the initial RM 1.7 billion to RM 4 billion was due to the new design concept for KLIA2 (Ng, 2015; Ghazali, 2015).

As mentioned above, many construction projects face delay and cost overrun due to design changes during construction. Based on the information researcher had on AirportExpansion project, there are frequent design changes after project sanction throughout the execution phase. Therefore, the main reason for this research is to identify the root causes of design change and their impacts. The study also recommended a possible means of resolution for problems encountered.

1.2 Statement of the Problem

Change is essential element of a project and a design change is a form of change that will deviate the way the work was planned, budgeted or scheduled. Almost all building projects experience various degrees of design changes through the project lifecycle. Design changes in building construction projects are common (Mohamad et al., 2012) where in many circumstances, these changes causes excessive claims and disputes (Howick et al., 2009). According to Iliyas et al., (2016) The most common effects of design change took place during construction stage were delay of the projects, increasing in cost of the project, abandoning of the project, wastage of materials and conflicts between the parties. Although, many researches have been conducted on the cause and impact of design changes in the execution phase of construction projects in many countries across the globe, very little has been done in Ethiopia which justifies the need for

further studies in this domain. Therefore, there is a need of conducting a research to fill these gaps.

Ethiopian Airline is one of the companies who are currently undertaking many construction projects in Ethiopia. Ethiopian Airlines is the flag carrier of Ethiopia, and one of the biggest and most profitable carriers in Africa. It was established in 1945 and is wholly owned by the Government of Ethiopia. The airline has its hub in Bole International Airport, located in Addis Ababa, capital of Ethiopia. The Ethiopian Airports Enterprise (EAE) is currently carrying out an expansion of the Bole International Airport, under a \$345 million contract with China Communication Construction Company, whereas the French Consulting firm Aéroports de Paris International (ADPI) is consultant of the project and the passenger terminal expansion building was designed by CPG, a renowned Singapore airport designing company. The expansion project was started at a cost of USD 250 million and because of additional works the project cost has escalated to USD 363 million. Based on the information researcher had on Airport Expansion project, there are frequent design changes after project sanction throughout the execution phase. Therefore, the research is focused on assessing the major causes and impacts of design changes in Airport Expansion Projects.

1.3 Research Questions

This study attempts to answer the following questions;

1. How frequent is the change of design in the Airport Expansion Project?
2. What are the major causes and impacts of design changes in Airport Expansion project?
3. Which contracting party/parties are more responsible in initiating majority of these causes and which are most affected?

1.4 Research Objectives

1.4.1 General Objective

- To assess major cause and impact of design changes in Airport Expansion project.

1.4.2 Specific Objectives

The specific objectives of this study are:

- To assess the existence and frequency of design change
- To identify the major causes and impacts of design changes
- To identify main initiators of these causes and most affected parties

1.5 Definition of Terms

Building design: - *is* the process of providing all information needed for construction of a building that meets its owner's requirements.

Design change: - For the purpose of this study, Design change refers to a modification or alteration on the working drawings at the construction phase of the project.

1.6 Significance of the study

As it is mentioned in the statement of the problem of this study, there is very little research conducted in Ethiopian focusing on the cause and impact of design change. Since there are few studies in the area, it gives a comprehensive starting point for more studies in design change related issues. Secondly, the findings of this research may have its own contribution on preventing/minimizing frequent design changes in future construction projects.

1.7 Scope of the study

This study mainly focuses on Bole International Airport Passengers Terminal 1 and 2 Expansion Project that Ethiopian Airports Enterprise (EAE) is currently carrying out which is

Design changes are caused by many factors such as Client-related factors, Contractors related factors, Consultant related factors etc. Therefore, it is important to identify both major causes based on their occurrence and their impact in Airport Expansion Project as well as the main

imitators of these causes and the most affected parties will be identified. The study covers professionals from client side that are engaged in the planning and implementation of the Airport Expansion projects, and some other stakeholders such as consultants and contractors. The researcher used different project documents to assess the major causes and impacts of design changes in the project. Moreover, questionnaires were used to collect the required data.

1.8 Organization of the thesis

The study is divided into five chapters, The first chapter discusses on background of the study, statement of the problem, objectives, scope and organization of the thesis. In the second chapter the basics of design change, its causes and impacts were discussed. Chapter three described the research methodology to be followed in order to achieve the objectives of the study. The results of the data obtained from projects document review and questionnaire survey were presented and discussed accordingly in Chapter four. Finally, in Chapter five, summary, conclusions and recommendations were forwarded based on the major findings of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

2.1.1 Theoretical Literature

In order to develop a better understanding of the research objective, a comprehensive literature review has been conducted focusing on identifying the major causes of design change and their impacts.

2.1.2 Basics of Building Design and Construction Projects

2.1.2.1 Define Building Design

According to Jonathan T. and Frederick S. (2001), Building design is that the process of providing all information needed for construction of a building that meet its owner's requirements and also satisfy public health, welfare, and safety requirements. Building construction is the process of assembling materials to form a building (Jonathan T. and Frederick S. 2001).

2.1.2.2 Building Design Stages

There are six stages of design and construction in construction projects (Alison, N. 2008).

However, on some projects, some of these steps may be combined or there may be additional ones. The phases are:

- **Conceptual Design**

It is the primary stage where by the client/employer and the architects sit and discuss on the requirements of the project. For instance, how many rooms are needed and what the functions of the spaces are and also the fitness between the owner's needs, wants and budget are tested (Alison, N. 2008).

- **Schematic Design**

In this stage, the architects give graphic shape to the owner's program. It goes through several revisions, because the primary design proposals prepared by the architects are rarely being approved by the owner. The architects communicate the design proposal to the owner including plans, elevations, sections, freehand sketches, and three-dimensional graphics (Mehta, et al., 2009).

- **Design Development**

In this stage, the architect and therefore the specialty consultants prepare design development documents to define further the dimensions and character of the project including architectural, civil, structural, mechanical, electrical, and other project components that can be used as a basis for working drawing development (Jonathan T. and Frederick S. 2001).

- **Construction Documentation**

At this stage inclusion involves preparation of construction documents such as drawings and specifications as well as preparation of the documents for bidding process (Jonathan T. and Frederick S. (2001).

- **Construction Bidding**

At this stage, the ultimate drawings and bidding documents organized during construction documentation stage are utilized in finding the competent contractor. When the contractor is procured, negotiation follows before awarding the contract (Scott, J. 2008).

- **Construction Administration**

It is the method whereby the Construction Manager/contractor in generally, working alongside the architect who acts as client/employer's agent to oversee construction to make sure conformity to construction drawings, specifications, and standards (Scott, J. 2008). In spite of the fact that there are five phases before construction start, change of design during the construction is much observed to affect the overall performance of the building projects.

2.1.3 Design Change

2.1.3.1 Define Design Change

According to Burati et al., (1992) design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related to matters in accordance with the provision of the contract and also changes to the work conditions. Likewise, Akinsola et al. (1997) noted that these changes are any additions, omissions or adjustments made to the original scope of work after a contract is awarded. It may cause a change to the contract price or contract time, and it occurs regularly on construction projects (Ibbs, 2012).

A design change is a form of change that deviates the way work is planned, budgeted or scheduled (Abdul-Rahman, Wang, & Yap, 2016)

2.1.3.2 Causes of Design Change

Design change often results from the terms like quality deviation/failure, non-conformance, defects/mistakes(Burati et al., 1992).To gain better insights on the design change dynamics, a strong understanding of causing factors is essential. There are many factors that influence design change during construction stage some of which lead to cause problems to the overall performance of building construction project (Chronicles, 2001). Design change in construction projects can be caused due to several reasons and at different stages, moreover in this context the focus is during construction stage. The cause of change can be from external or internal issues that may occur during the development phases of project i.e from basic design to construction (Gharaee M., 2012).

2.1.3.2.1 Internal Factors

According to Iliyas et al., (2016), the internal factors are caused by parties directly involved within a construction project such as the owners, design consultants, managing consultants and contractors. The following are internal factors leading to change of design during construction stage;

- **Client Related Factors**

According to a study by Mohamad et al. (2012), design changes are greatly initiated by the clients. They listed three major causes of design changes credited to the clients were “modifications to the original design”, “addition of new work/scope” and “unclear initial design brief”. Some other significant causes consists of “desire to use better specification”, “desire to use alternative material/new technology” and “omission of works/scopes”.According to Hwang, Zhao and Goh (2014), client-related factors are “change of plans or scope by the client”, “inadequate/ un comprehensive project objectives by the client”, “change in specification by the client”, “financial problems faced by client”, “impediment in prompting the decision making by the client”, “replacement of materials by the client”, “change in specification by the client”, and “obstinate nature of the client”.So, client values are important and should be fully understood at the early phase of the project (Thyssen et al., 2010).

- **Design Related / Consultant’s Factors**

According to Mendelsohn (1997), almost 75% of problems or reworks on construction project were induced at the design phase. The lack of communication between design consultants can lead to mistakes and oversights in project documentation (Love et al., 2004). The design and delivery team often misinterpret the client’s requirements in the project (Koskela et al., 2002; Thomson et al., 2003). Mohamad et al. (2012) stated factors that caused design changes in residential reinforced concrete buildings as follows; inconsistent information in drawings, lack of geotechnical investigation/ wrong interpretation of findings and insufficient detail of existing site condition, improper design/ part of design improvement, the discrepancy between contracts. similarly, Iliyas et al., (2016) described non-availability of engineering licensing for engineers; unrealistic period to design; failure of a consultant to provide adequate and clear information in the tender documents; errors and omission of consultants; changes made as a request of a consultant; consultants who are not familiar with the regulations and construction permits; low consultant fee and poor coordination of design team members with the owner; The presence of conflicts between contract documents; Lack of consultant’s knowledge of available material and equipment; The underestimate of the cost of the project; Unclear and inadequate details in

drawings; Production of Structural detail does not match Architectural detail; the lack of precise and rapid decisions and there are not carefully check and correct planning documents; Improper supervision of the work executed by contractor; as factors contributing to design changes in construction projects.

- **Site-Related Factors**

Project specific dynamics include location conditions (Love et al., 2002) and underground conditions (Hsieh, Lu, & Wu, 2004; Mohamad et al., 2012; Sambasivan&Yau, 2007). The inherent site conditions of a project will affect the project performance (Frimpong et al., 2003).

- **Contractor's Factors**

According to Mohamad et al. (2012), design changes induce by the contractor are “due to contractor’s request to use the available material”, “to rectify construction mistakes”, “to use alternative construction method to save time”, “to use alternative construction methods to save lots of money”, and “to improve the standard of works at site”. Also, modification of construction methods to ensemble current site conditions, contractor request for original construction methods to be changed by a new method as well as improper construction or human errors leading to on-site repair work are listed by Wu et al. (2005). On the other hand, Sun and Meng (2009) included “poor site/project management skills”, “delays in appointing subcontractor”, “delay of subcontractors’ work”, “poor workmanship”, “low productivity”, and ‘poor logistic control” as the relevant factors. A study by Iliyas et al., (2016) reported that Contractors has factors consisting of an unrealistic construction’s schedule; and the construction budget is too low; Lack of contractor’s involvement in design; Contractor’s desired profitability, cost escalation & financial problem; Contractor’s change requests for easier operations, higher income, within the allowable limits for the project; Lack of coordination among members with design team.

2.1.3.2.2 External Factors

According to Iliyas et al., (2016), the external factors are factors or parties that are not directly involved in a construction project but they affect design changes such as political and economic

matters, the natural environment, the advances of technologies and third parties. The following are external factors that lead to change of design during construction stage;

- **Political and Economic Factors**

Project outcome is most impacted by the regulation imposed by the government (Love et al., 2002). Hsieh et al. (2004) described “Change of work rules/regulation by the government agencies”, “neighborhood communities” and “coordinates with utility systems” as some of the external factors. On the other hand, Sun and Meng (2009), Chang et al. (2011), Wu et al. (2005) and Chang (2002) also recognized change orders owing to legislative or policy changes as a critical external factor in their study. Alaghbari et al. (2007) further extended the factors to include “materials on the market”, “equipment and tools on the market”, “economic conditions”, “law and regulation”, and “external works due to public agencies (roads, utilities and public services)”. Aiyetan, Smallwood and Shakantu (2011) means “physical environmental conditions”, “economic policy” and “socio-political conditions” as factors in their study. According to Iliyas et al., (2016), Political and economic matters have factors that consist of changes in policies and regulations; decision maker alteration and the effect of inflation and price; Unavailability/shortage of materials; Change of market demand of the intended use of buildings fluctuate.

- **Environmental Factors**

The environment has factors that consist of weather conditions; natural disaster; geological conditions and unforeseen ground conditions (Iliyas et al., 2016).

- **Third Parties’ Factors**

Doloi et al. (2012) argue that lack of communication with local authorities will affect project performance. Third parties have factors that contains of complaints from neighborhood; the changes made because the request of an end user/regulator body; the request from investor who came while construction has started (Iliyas et al., 2016).

2.1.4 Impacts of Design Change

Overruns in project schedule and project cost are basic principles for a successful project that are adversely impacted by design changes (Chan & Kumaraswamy, 1996; Frimpong et al., 2003). There are many researchers whose research output found that change of design of building projects cause negative impact in building construction. For instance the research done by (Kikwasi, G.J. 2012) which based on assessing the causes and effects of delays and disruptions in construction projects in Tanzania stated that, the design change was one of the major causes that affecting performance and causing disturbances in construction projects in Tanzania. Although for developed economy of the UK, design changes top the list of both time and cost overrun factors (Olawale & Sun, 2010). Almost all projects undergo various degrees of design changes throughout the project lifecycle. Even though design changes are widely accepted by practitioners in the construction industry, however, they have undesirable adverse consequences on project outcomes (Mohamad, Nekooie, & Al-Harthy, 2012). Impacts that are related to change of design during construction stage described as follows;

- **Delay of the Projects**

Studies on the causes of delay and cost overruns (e.g. Assaf & Al-Hejji, 2006; Kaming et al, 1997) found that design changes are acknowledged as a crucial problem. (Iliyas et al., 2016) found that when there is change of the design during construction, project completion period increases due to, designing of the new changes in structural, services and architectural design as well as the approval of the new drawings and appraisal of the new materials will need time. Henceforth at the end the project duration will be increased. Memon et al. (2014) divided the causes of delay into two broad categories: excusable delays and non-excusable delays. Excusable delays were more orientated to the client or consultant causes, while the non-excusable delays were related to the contractor. Design change in particular was defined as a cause in excusable delays.

- **Change of Cost of the Project**

Burati et al., (1992) found that design and construction produced the greatest deviation of construction costs. The deviation was 12.4% of the entire cost of a project. They suggested that the deviation caused by design changes was 78% of the total deviation, 79% of the deviation of

costs and 9.5% of total construction cost. They also found that two third deviations are caused by a design change. According to Iliyas et al., (2016), when design changes occur during construction stage, there is a tendency of the cost of the project to change. Addition of more money will be required if the design changes are complex or increase the project scope. As such, some of the changes require new items that can be more expensive than first proposed ones; also there is some of the extra cost that would be resulted due to extension of the time. In another study, Cheng (2014) asserted that most significant factors for cost overrun include the unclear and poorly defined scope of the project, numerous modifications to the scope, and unclear drawings/guidelines/regulations. These factors lead to design changes at any stage of a project thereby resulting in some reworks and do affect not only the cost but also have a diminishing return effect on the morale of workers. Also, Ibbs (2005) [14], emphasized the substantial loss of labor productivity due to design changes and eventually resulting in cost overrun and delay.

- **Wastage of Materials**

Some changes of the design during construction are associated to the wastage of materials. This will happen in circumstances where design changes compel some areas of the already constructed elements of the building structure to be demolished (Iliyas et al., 2016).

- **Conflicts between the Parties**

Also changes of the design during construction may result into the conflicts between members of the project. This might occur especially when the design is at fault and the constructor has proposed changes to facilitate constructability. In such occasion if such changes increase the cost of construction, the client might wrangle with the consultant for such an incompetent initial design that makes the client incur extra cost and disturb the budget (Iliyas et al., 2016).

- **Demolition and Rework**

Previous studies have also indicated that significant rework in construction is due to design changes (Love et al., 1999; Love, Mandal, Smith, & Georgiou, 2000; Love, Edwards, & Irani, 2008; Sommerville, 2007). Also, a study by Burati et al. (1992) revealed that 79% of rework costs arising in industrial engineering projects were the result of design changes, errors and omissions. As stated by Hwang et al. (2009) [26], almost \$75 billion was wasted on direct cost as a result of rework in 2004 alone, thereby imposing a heavy burden on the construction industry

in the USA. In another research conducted in Singapore on the analysis of data collected from 381 projects, the average cost overrun was determined to be 7.1%. These mostly related on to owner induced changes which resulted in rework. The design changes are the first explanation for rework which affected the costs excessively. Design change-induced rework can account for nearly 50% of cost overruns (Love, 2002). Schedule delay from reworking is due to lower productivity because of loss of work rhythm and lower workforce morale when a completed section of work entails further dismantling and reinstallation. The reasons are obvious: design-change induced-rework leads to increase the cost due to the further efforts of disassembling and restarting some completed works (Emuze, Smallwood, & Han, 2014; Yap, Low, & Wang, 2017), leading to the loss of project productivity (Cooper & Reichelt, 2010) and more wastage (Kakitahi, Alinaitwe, Landin, & Mone, 2016) When rework increases, the project cost, and schedule is likely to increase, which eventually leads to unnecessary disputes and claims (Ibbs & Liu, 2005).

2.1.5 The Ten Knowledge Areas

The ten knowledge areas are the abilities a project manager must exercise and master to manage a project efficiently. All knowledge areas given within the PMBOK Guide® follow identical naming convention. Most times, they are mentioned the precise middle word of the respective knowledge area.

Project Integration Management:

The knowledge area which is dedicated to identify and define the work in the project is known as the Integration Management. This knowledge area deals also within the efficient integration of changes into the project.

Project Scope Management

This knowledge area deals with defining the project scope, project requirement scope, project work, making the work breakdown structure, making the scope baselines and managing the scope of the project. This is the one point where you will plan ways to keep the project within the established boundaries.

Project Time Management:

The project managers estimate the duration of the tasks during this knowledge area. This is where he/she sequences the tasks and chooses the number of resources necessary to achieve the objective of the project. Schedule is monitored and managed here in this area to keep the project on the track.

Project Cost Management:

Budget baseline is established and costs are projected in this knowledge area. The plan to manage the costs is classified within the cost management knowledge area too. This knowledge area consists of four processes.

Project Quality Management

There are three processes in Project Quality Management, the knowledge area where the quality requirements for project deliverables are planned and tracked. In this area, all the quality issues are checked and fixed.

Project Human Resources Management

This knowledge area, which is that the Human Resource management of the project involves the processes very essential to define the ways human resources are going to be utilized, developed, acquired and managed.

Project Communications Management

Communications management is the knowledge area that describes how communications within the project will work. In these processes, the project manager creates the communication management plan, confirms the plan is followed, and controls information flow within the project.

Project Risk Management

Project Risk Management involves of identifying risks, planning risk management, conducting risk assessments, and controlling risks. The area focuses on identifying, analyzing, planning responses to both 'threat risks' (negative) and 'opportunity risks' (positive).

Project Procurement Management

This knowledge area deals with the processes which project managers commonly follow to gain required material for the successful completion of the project. In this knowledge area, project managers emanate plan for conducting procurements, controlling the procurements and closing out the procurements.

Project Stakeholder Management:

Project Stakeholder Management area covers all the processes which is used by a project manager for identifying and satisfying the ones who are affected by the project. The affected party can either be internal or external. You can pay close attention to those stakeholders who can have a powerful positive or negative impact on the project.

2.2 Empirical Review

Yap and Skitmore (2018) investigate the various reasons for design changes in Malaysian building projects. They conducted a review of the extensive literature to categorize the 39 causes into those related to the project (1) client, (2) consultant, (3) contractor, (4) site, and (5) external. The three most significant causes observed are poor coordination among various professional consultants, variations in the specification, and frequent changes to scope requirements.

Design changes in construction projects will inevitably lead to cost overrun or schedule delay (El Razeq, Bassioni, & Mobarak, 1995; Kaming, Olomolaiye, Holt, & Harris, 1997; Le-Hoai, Lee, & Lee, 2008; Owalabi et al., 2014). Overruns in project schedule and project cost are basic principles for a successful project that are adversely impacted by design changes (Chan & Kumaraswamy, 1996; Frimpong et al., 2003). Rework has become a prevalent feature of the procurement process in construction that always leads to time and cost overruns in projects (Josephson et al., 2002). Previous studies have also indicated that significant rework in

construction is due to design changes(Love et al., 1999; Love, Mandal, Smith, & Georgiou, 2000; Love,Edwards, &Irani, 2008; Sommerville, 2007).

A study by Cox, Morris, Rogerson and Jared (1999) discovered that design changes often have a main impact on the client objectives in construction projects where the cost related with post contract award design changes naturally amount about five to eight percent of the contract value. Chang, Shih, and Choo (2011) described that design changes has resulted in an increased in redesign cost of 2.1% to 21.5% and on average 8.5% of the construction change cost. Also, a study by Burati et al. (1992) revealed that 79% of rework costs arising in industrial engineering projects were the result of design changes, errors and omissions. Williams, Eden, Ackermann and Tait (1995) also stated that design changes and delays in design approval would have caused delay to the project. Certainly, design changes are on-going problems that continue to raise concerns in the construction industry.

2.2.1 Empirical Findings on Design Change

✚ **Tanzania;** Research done by (Kikwasi, G.J. 2012) which based on assessing the causes and effects of delays and disruptions in construction projects in Tanzania, found many reasons as a cause and described design change as a major causes affecting performance and causing disruptions in construction projects in Tanzania. Therefore, the ability to predict the probabilities of occurrence (Abdul-Rahman et al. 2006) is essential to mitigate overruns and possible disputes due to design changes and rework.

✚ **Saudi Arabia;** In a research conducted by Ikediashi et al.(2014) , on construction projects, they concluded that design discrepancies and frequent design changes are the most important factors resulting into cost overrun, and ultimately leads to complete failure of projects in Saudi Arabia.

✚ **Indonesia;** Kaming et al. (1997) studied the influencing factors on thirty one high-rise project in Indonesia and found that design changes is one of the most important factors

causing time overrun. This statement is further supported by studies of Apolot, Alinaitwe, &Tindiwensi (2013) in Uganda, Rosenfeld (2013) in Israel, Yang, Chu, & Huang (2013) in Taiwan, Ijaola&Iyagba (2012) in Nigeria, Alnuaimi et al. (2010) in Oman, Le-Hoai et al. (2008) in Vietnam, Assaf& Al-Hejji (2006) in Saudi Arabia, Sweis, Sweis, Hammad, &Shboul (2008) in Jordan, Kartam, Al-Daihani, & Al-Bahar (2000) in Kuwait, and Ogunlana et al. (1996) in Thailand.

✚ **Malaysia;** A study by Shehu et al. (2014) conducted 359 samples of a questionnaire survey of Malaysian quantity-surveying consultants and reported that an alarming 55% of projects in Malaysia suffer from cost overruns. The most prominent concern related to design changes that happened in Malaysia is the construction of Kuala Lumpur International Airport 2 or known as KLIA2. The initial target date for opening was September 2011 but was later moved several times and finally completed in May 2014. The construction cost ballooned from the initial RM 1.7 billion to RM 4 billion was due to the new design concept for KLIA2 (Ng, 2015; Ghazali, 2015).

✚ **California;** A study by Chang (2002) stated that cost increased on average of 24.8% and schedule increased on an average of 69% based on four sampled projects in California as a result of design changes.

2.3 Summary of Findings of Literature Review

In order to have conceptual and contextual basis on the research objectives in depth literature review have been conducted on identification of causes and impact of design. A number of studies on causes of delays and cost overruns in construction projects have highlighted design changes as major contributing factor. Therefore, the study will focus on identifying causing factors of design changes, because a good understanding of causes is a prerequisite for preventing/minimizing frequent design changes. It is also important to identify the different causing factors of design changes particularly in Airport Expansion construction project before looking into the impact of design changes to the project.

2.4 Conceptual framework

In this literature review, the relevant causing factors to the design change identified. In this paper, causing factors divided in to two; internal such as: client related, design/consultants related, contractors related and site related factors and external such as: political and economic, third parties and environmental factors are considered to be causing factors contributing to the design changes in Airport Expansion project construction. Therefore, the conceptual frame work of this research is presented in figure 2.4.1 below.

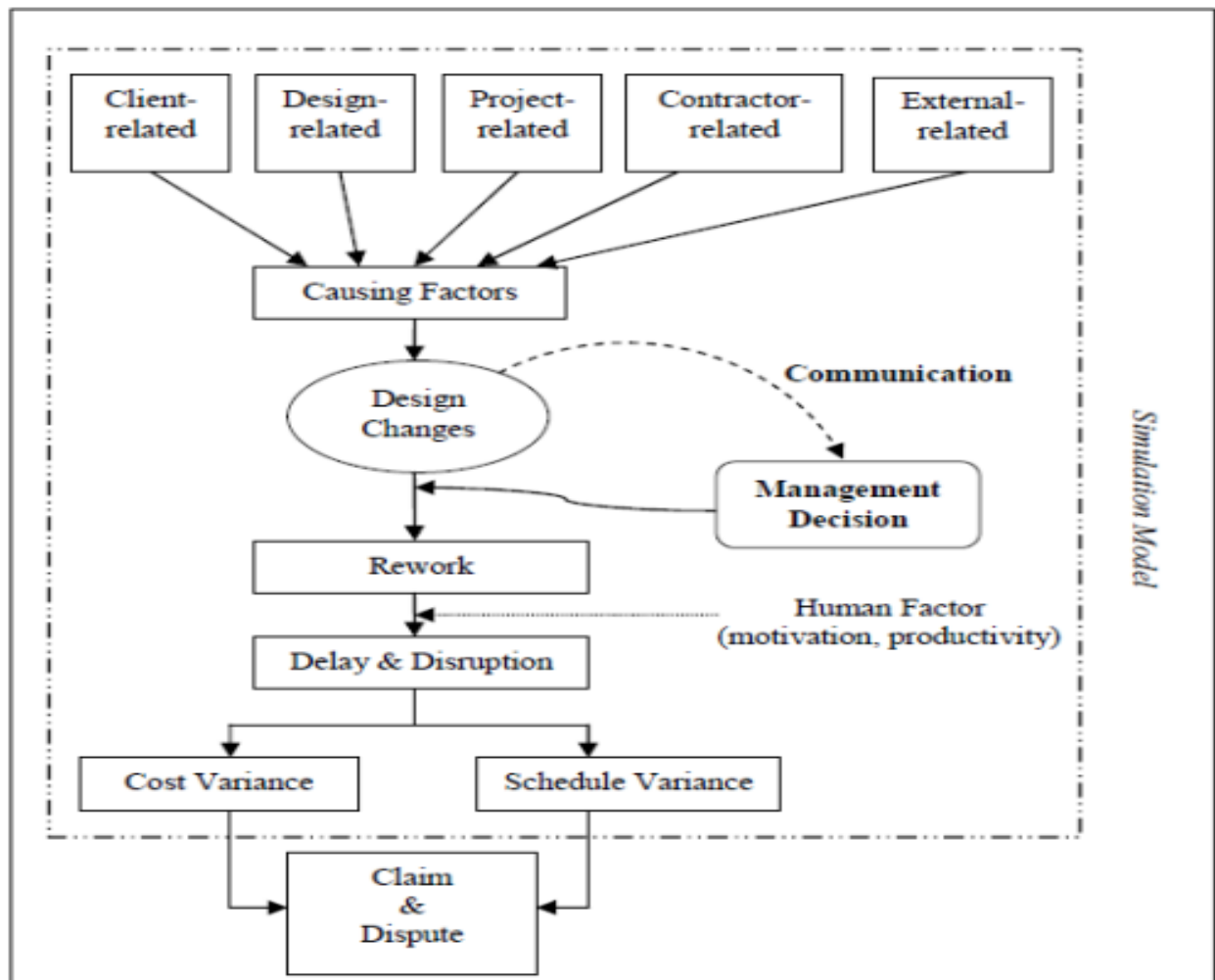


Figure 2.4.1, conceptual framework (Source: Jeffrey, et.al, 2016)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

Research design is specific research methodology philosophies and techniques used to achieve the objective of the study. In this research, the research questions were oriented to identify existence and frequency of design change including the major cause and impact in these particular projects. So, For this research, the research design is descriptive, It is descriptive, because the research basically focuses on practical projects to identify and describe the existence and frequency of design change, major cause and impacts through identifying rate of occurrence and also showed main initiators and most affected parties as a result of the impact.

3.2 Research Approach

The research problem along with the philosophy of research methodology would guide the choice of the appropriate research method. Creswell and Borrego described three research approaches: such as qualitative, quantitative and mixed methods (Creswell, 2013). Based on the character of the research questions, this study adopted mixed type of research approach because it involves collecting and analyzing qualitative and quantitative data in order to get better understanding of the research problem than either of each alone. By mixing both quantitative and qualitative research approaches, the research gained depth of understanding while offsetting the weaknesses innate to using each approach by itself.

3.3 Census Techniques

Census technique is advantageous because it provides a true measure of the population rather than sampling techniques, full information about small sub-groups in the population is more likely to be Obtained, Calleam Consulting Ltd(2012). For this reason, when a total population of the study is less than 100, it is preferred to apply census techniques rather than sampling techniques.

Defined target population of this study particularly includes professionals from client, consultant and contractors side that had first degree and above in engineering fields who are engaged in Bole Airport Expansion Project since they are qualified to explain and respond to the required inquiry as per researcher interest. Based on the information obtained from Human Resource office, a total of 61 professionals with the above criteria are currently working on the project. So, taking this figure as a starting point that limits the total population of this study, respondent distribution was undertaken through census techniques, which are 15 respondents from clients (project owners), 25 respondents from contractors and 21 respondents from consultants.

3.4 Source and Tools/ Instruments of Data Collection

For the analysis, both primary and secondary data were used. Primary data are data collected first hand by the researcher for the specific purpose of study, while secondary obtained from sources already existing in the concerned organizations or by stakeholders of the project to be studied. Secondary data was obtained by reviewing major project documents and primarily data were collected by distributing open ended and close ended structured questionnaire to selected clients, contractors and consultants.

The answer for the structured questionnaire was rated based on Likert's-scale of five ordinal measures of agreement on each contributing factors (from 1-5) to identify major causes. For the impact part respondents were requested to rate the degree of impact based on their experience. First the possible factors that causes design changes are identified, in this case respondents were asked about their agreement on whether design change in Airport Expansion Projects are a problem or not based on the following scale of measurements.

- Agree
- strongly agree
- Disagree
- strongly disagree

After this they are asked to rate the frequency of design changes in Airport Expansion Project.

Once these basic questions are answered by the respondents then they are asked about the potential of each factor in causing design changes according to the frequency of occurrence and for the degree of impact, based on the following scale of measurements.

For frequencies of occurrence

- 1- No occurrence
- 2- Low occurrence
- 3-Medium occurrence
- 4- High occurrence
- 5-Very occurrence

For degree of impact

- 1- No impact
- 2- Low impact
- 3-Medium impact
- 4- High impact
- 5-Very High impact

After identification of the most important factors that contributes in causing designchanges, respondents are asked to indicate the responsible parties for the causes and mostaffected party/parties.

3.5 Methods of Data Analysis

For this study, only descriptive method is employed in the data analysis. The data collected for this study were analyzed by using the Statistical Package for Social Science (SPSS) 22.0 package. The data collected from the questionnaire, then coded and entered into the software to compute the specified statistics, including the mean. The mean score method of analysis was implemented to rank the causes and impact of design changes in Airport Expansion projects based for on frequencies of occurrence. The main initiators and most affected parties were described as a percentage of respondent responses. The data gathered from both primary and secondary sources analyzed and summarized in tables and figures.

CHAPTER FOUR

RESULTS AND DISCUSSION

This part of the research deals with the analysis and discussion of the data gathered through questionnaire survey and reviewing important project documents.

The investigation of Questionnaires survey comprises first the respondents' opinion on the existence and frequency of design change in Airport expansion projects. Then, identification of major causes, the initiators of the causes and most affected parties with each causes side by side in order to obtain a continuous flow since the variables were interconnected each other. Finally, respondents were asked to rate the degree of identified impacts in Airport Expansion Project and then, they were asked to forward possible measures to be taken in order to minimize design change and its impact.

In addition to the questionnaire survey, important project documents were reviewed in order to understand the reasons behind each design change and identify its impact.

4.1 Questionnaire Survey Response Rates

A total of 61 questionnaires distributed for clients, consultants and contractors which are involved in Airport Expansion projects. Out of the distributed 61 questionnaire booklets, 43 professionals responded to the survey which is 9(60 %), 15(71 %), 19(76%) from Client, Consultant and, Foreign Contractor respectively. Before starting the analysis, the returned questionnaire booklets were checked for their reliability. The details of respondent responses and their rating are summarized in Table 4.1.1.

Table 4.1.1; Questionnaire survey response rates

Respondents Category	Questionnaire Distributed	Questionnaire Returned	Percentage Returned (%)
Client	15	9	60
Foreign Consultant	21	15	71
Foreign Contractor	25	19	76
Total	61	43	70

Table 4.2.1 below, attested that the majority of the respondents 90.7% (39) participated in the survey were males and 9.3% (4) were females, respectively. In general, the table below conformed that majority of the respondents are males between 25-35 years old, which shows that few number of females participated.

4.2 Demographic Characteristics of the Respondents

Table 4.2.1, Demographic Characteristics of the Respondents

	Sex		Citizenship		Age					
	M	F	Ethiopian	Foreigner	25-30	31-35	36-40	41-45	46-50	>50
Frequency	39	4	41	2	23	10	2	3	3	2
Percentage	90.7	9.3	95.3	4.7	53.5	23.3	4.7	7.0	7.0	4.7

Table 4.2.2 below generally indicated that, 83.7% (36) respondents participated in the survey were 1st degree holder and the remaining 16.3% (7) had obtained 2nd degree in construction engineering, and similarly, the majority of respondents 48.8% (21) & 25.6% (11) involved in the survey had 0 to 10 years total work experience in the construction industry which shows that the respondents were competent enough and capable to participate in the survey.

Table 4.2.2, Educational Background & Work Experience of the Respondents

	Educational Level						Occupational Level				
	1 st Degree		2 nd Degree				Managerial		Non-Managerial		
Frequency	36		7				9		34		
Percentage	83.7		16.3				20.9		79.1		

	Respondents Experience						Company Experience				
	0-5	6-10	11-15	16-20	21-25	>25	0-5	11-15	16-20	21-25	>25
Frequency	21	11	2	6	1	2	4	3	11	15	10
Percentage	48.8	25.6	4.7	14.0	2.3	4.7	9.3	7.0	25.6	34.9	23.3

4.3 Results

4.3.1 Existence of the problem

The first step in this research was to check whether design change exists and it is a problem in Airport expansion projects as well as the Ethiopian construction industry.

To answer this question, data was gathered from professionals involved in Airport expansion projects and they were asked to express their opinion on whether design change is a problem or not in Airport expansion projects as well as in Ethiopian construction industry. The result (data) obtained from the survey revealed design change as one of the major problems in airport expansion projects and this is also an indication it is a problem in Ethiopian construction industry too.

As it is indicated in Fig. 4.1.1 below 83.3 % of the respondents for this research acknowledged design change as one problem in Ethiopian construction industry, the remaining 16.7% however do not agree on the subject of design change as a problem. Out of the 83.3%, 25% (30%) of the respondents strongly agreed and 58.3% (69.98%) simply agreed on design change as one of the major problems in airport expansion projects.

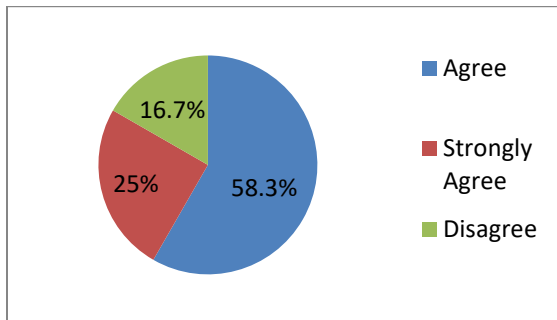


Fig. 4.3.1 Respondent responses on whether Design change is a problem

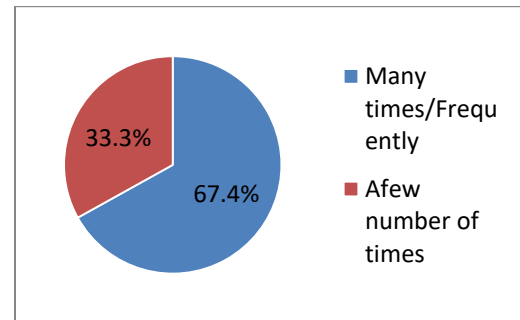


Fig. 4.3.2 Respondent responses on frequency of design change

On the other hand, fig 4.1.2 indicated that 67.4 % of the respondent approved that design changes have been made many times/frequently in airport expansion projects while the remaining 32.6% agreed on a few number of times.

4.3.2 Internal and external Causes of Design Changes

After identifying from literature review the different factors that cause design change, questionnaire was prepared, incorporating 32 factors categorized in 8 groups and the responses

for internal cause of design change are ranked in Table 4.3.1 below according to their mean scored.

4.3.2 Mean Scores (MS) and Ranks (R) for Internal Causes of Design Changes

Major Causes of Design Change (Internal Factors)	Rate of Occurrence		Main Initiators (Percentage %)		
	MS	R	CL	MCS	CT
1. Client - related					
1.1 Changes requested by the owner	3.33	1	83.3	16.7	
1.2 Owner's change of schedule due to financial Problem	0.63	21	75.0	8.3	16.7
1.3 Owner fails to review document at the right Time	2.87	3	41.7	41.7	16.7
1.4 Incorrect/unclear information given at initial stage of Design	2.70	4	41.7	33.3	25.0
1.5 Obstinate nature of client (not considering others constructive idea)	1.80	12	91.7		8.3
1.6 factor related to corruption	1.83	11	58.3	8.3	33.3
2. Design - related					
2.1 The unrealistic period to design	1.33	18	41.7	50.7	8.3
2.2 Inadequate information in the tender documents; errors and omission.	1.70	14	41.7	33.3	25.0
2.3 conflicts between contract document (drawing Vs specification)	1.87	10	34.6	49.4	16.0
2.4 poor design quality, design error	2.10	7	66.7	16.7	16.7
2.5 poor communication among design Team & with client	1.87	9	32.4	57.5	10.1
2.6 Lack of knowledge available resources	1.30	19	50.0	16.7	33.3
2.7 lack of geotechnical investigation	0.87	20	33.3	16.7	50.0
3. Managing consultant-related					
3.1 poor communication of responsible parties	2.97	2	25.0	58.3	16.7
3.2 The changes requested by the consultant	1.53	17	25.0	75.0	
3.3 Lack of precise and rapid decisions	2.50	5	25.0	50.0	25.0
4. Contractor – related					
3.1 The unrealistic construction's schedule	1.63	16	8.3	33.3	58.3
3.2 The changes initiated by contractors	2.10	6	25.0		75.0
3.3 Rectify construction mistakes	1.77	13	41.7	25.0	66.7
3.4 Poor site/project management skill	1.57	2	41.7	25.0	33.3
3.5 Lack of contractor's involvement in design	1.93	8	16.7	16.7	66.7
5. Site – related					
5.1 unforeseen underground condition	1.67	15	33.3	25.0	41.7

Table 4.3.2 above, presents the MS and R, for internal causes of design changes and presented main initiators for each identified causes in percentage. These internal causative factors identified by the respondents involved in the survey were ranked by using statistical mean by employed SPSS V.22, from these, the top five internal causes of design change occurred in Airport Expansion Projects are “Change requested by the owner”, “poor communication between responsible parties”, “owners fail to review document at the right time”, “incorrect/unclear information given by the owner at initial stage of design” and “lack of precise and rapid decision” respectively. The clients, consultants and contractors members all initiated design changes of different magnitudes. Table 4.3.3 shows that main initiator for most of the internal causes of design change are clients based on percentages of respondents.

Similarly, Table 4.3.2 below presents the MS and R, for external causes of design changes and presented main initiators for each identified causes in percentage. These external causative factors also identified by the respondents involved in the survey and were ranked by using statistical mean by employed SPSS V.22, compared to the internal factors the external factors has lowest mean score value which indicated that this factors has less occurrence in Airport Expansion Projects.

Table 4.3.3 Mean Scores (MS) and Ranks (R) for External Causes of Design Changes

Major Causes of Design Change (External Factors)	Rate of Occurrence		Main Initiators (Percentage %)		
	MS	R	CL	MCS	CT
6. political and economic factors					
6.1 The changes in policies and regulations	1.03	6	83.3	16.7	
6.2 Inflation and price fluctuation	1.90	1	75.0	8.3	16.7
6.3 Unavailability/shortage of materials	1.30	2	41.7	41.7	16.7
6.4 Change of market demand	1.03	7	41.7	33.3	25.0
7. environmental factors					
7.1 Changes of weather conditions	1.13	4	58.3	8.3	33.3
7.2 Occurrence of natural disaster such as, flood, earthquake, etc.	0.47	8			
7.3 Insufficient information on geological conditions	0.63	9	41.7	50.7	8.3
8. third parties factors					
8.1 The request made by end user	1.10	5	34.6	49.4	16.0
8.2 The request from regulatory bodies	1.17	3	66.7	16.7	16.7
8.3 The request from investor who came while construction has Started	1.03	10	32.4	57.5	10.1

Based on the above result of the analysis from respondent’s response Major causes of design change in Airport Expansion projects were identified. Table 4.3.4 below summarized the major causes of design change in Airport Expansion projects.

Table 4.3.4, Major causes of design change in Airport Expansion Projects

Major Causes of Design Change	Rate of Occurrence	
	MS	R
Changes requested by the owner	3.33	1
poor communication of responsible parties	2.97	2
Owner fails to review document at the right Time	2.87	3
Incorrect/unclear information given by the owner at initial stage of design	2.70	4
Lack of precise and rapid decisions	2.50	5

The result showed that “Change requested by the owner”, “poor communication between responsible parties”, “owners fail to review document at the right time”, “incorrect/unclear information given by the owner at initial stage of design” and “lack of precise and rapid decision” as the most important causes of design change in Airport Expansion projects. This indicated that the internal factor has more effect in causing design changes in Airport Expansion Projects. Besides identifying the major causes respondents were also asked to indicate the initiators of the causes and based on the percentage of the respondents clients (66.7%) are the main initiators of most design changes occurred in the project. The result also showed that consultants (21%) are the next party which is responsible in causing most of the causes and the remaining 12.3% are contractors. The result summarized as it is shown in the (Fig 4.3.2) below.

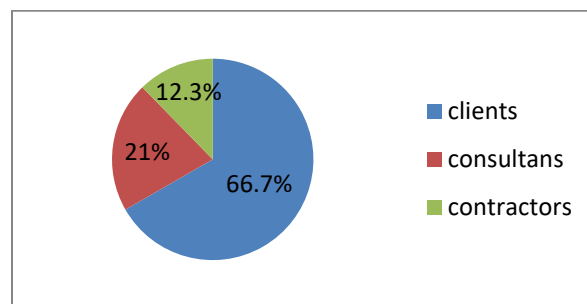


Fig. 4.3.2 Respondent responses on the more responsible parties/ Main Initiators

4.3.3 Major Impacts of Design Change

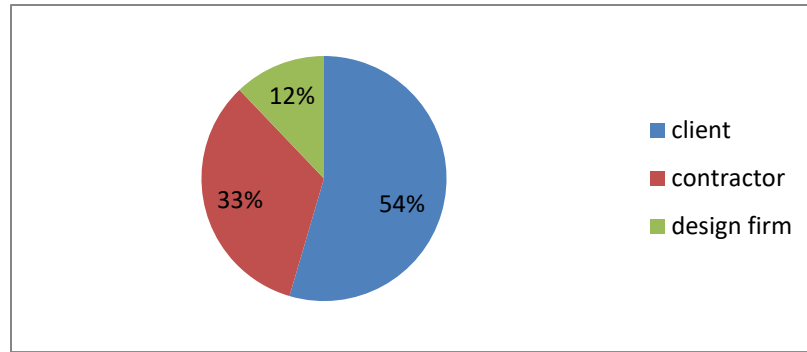
In addition to identification of causes, a section of the questionnaire contained 8 major impacts of design change identified from literature review. Respondent were asked to rate the degree of impacts as “No Impact “, “Low Impact “, “Medium Impact “, “High Impact “ and “Very High Impact “in order to identify the major ones in the case of Airport Expansion Projects and also establishing general knowledge for professionals in the construction industry on the negative aspects of design changes to minimize avoidable design changes later. The result of this analysis is tabulated in Table 4.3.3 below.

Table 4.3,3, Mean Score (MS) and Rank (R) for impact of design change

Major Impacts of Design Changes	Degree Of Impact	
	MS	R
Increase in project costs (cost overrun)	3.33	1
Delay of the project (time overrun)	3.08	2
Decrease in quality of work	2.33	4
Decrease in productivity	1.17	7
Demolition and Rework	2.75	3
Wastage of materials	2.08	5
Damage firm reputation	0.92	8
Results dispute among parties	1.75	6

From the results of the analysis in table 4.3.3, “increase in project cost”, “delay of project”, “demolition and rework”, “wastage of material” and “decrease in quality of work” ranked 1 to 5 respectively, based on their mean score and identified as major impacts of design change among the 8 major impacts which has been identified from literatures.

After they identified causes, more responsible parties in initiating these causes and impacts of design change, respondents were also asked to indicate the most affected parties as a result of impacts of design change in Airport Expansion Project. Based on this, Fig 4.4.1 below shows respondents’ response on which contracting party is more affected as a result of design change and 54% of respondents confirmed that clients are the most affected parties and the remaining 32% and 12% are contractors and design firm respectively.



4.3.4 Respondent responses on the most affected parties as a consequence of Design Change
 Besides addressing the main objectives of identifying the major causes, initiators of the causes, most affected parties and the major impacts of design change respondent were also requested to forward their opinions on how to minimize design change so as to minimize their impacts.

- Owner should give clear and sufficient information regarding its need & interest to the design team at the early stage of the design.
- Gather sufficient information before and during early stage of design.
- Involve Excellent and well experienced professionals in design.
- Involve all stakeholders in the design process.
- Pre-review of documents before tender
- Proper feasibility study, detail design considerations and detail review through all the documents.
- Follow strict procedure in review and approval of design.
- Fast and common way of communication with clients and between different working disciplines
- Rapid decision making on design change

4.4 Major Findings and Discussions

Through the questionnaire survey, the most important causes and impacts of design change in Airport expansion projects were analyzed and tabulated. From the result obtained, the five major causes, their initiators, impacts and most affected parties with each of these significant causes and impacts of design change were identified and will be discussed below.

4.4.1 Major causes of design change

In this section, the five major causes of design change identified based on their mean score will be presented and discussed. Based on this, “Change requested by the owner”, “poor communication between responsible parties”, “owners fail to review document at the right time”, “incorrect/unclear information given by the owner at initial stage of design” and “lack of precise and rapid decision” are the top five major causes in terms of rate of occurrence and will be discussed in the following paragraphs.

- **Changes Requested by the Owner**

The first most significant causes identified as major causes of design change in Airport Expansion Project is changes requested by the owner. According to a study by Mohamad et al. (2012), design changes are greatly initiated by the clients. They listed three major causes of design changes credited to the clients were “modifications to the original design”, “addition of new work/scope” and “unclear initial design brief”. Client values are important and should be fully understood at the early phase of the project (Thyssen et al., 2010). In a study conducted by Ayininuola and Olalusi (2005), the frequent changes in the design were associated with a change in scope of work by owners. It is a well-established fact that design changes are the major contributor to cost overrun in construction projects.

In the context of the Airport Expansion Projects, changes requested by the owner is related to “modifications to the original design”, “addition of new work/scope”, “omission of work/scope”, “change in specification”, “replacement of material”, etc. which has the same nature in what is discussed in the above paragraphs from literatures. As it is clearly indicated in Table 4.3.1, the cause is ranked first based on the mean score. This implies that change requested by the owner is one of the serious problems which results design change in Airport Expansion Project. This type of problem occurred due to many reasons such as insufficient planning at the project definition stage, lack of proper consultation with owner at the design stage, etc.

- **Poor Communication of Responsible Parties**

The second major cause of design change in Airport Expansion Project identified in this research is poor communication of the responsible parties which agrees with a study by Iliyas et al., (2016), stated failure of communication amongst parties involved as a common factor to design

change. The study also concluded that the good performance and success of a building construction project, to a large extent, is determined by the ability and effectiveness of the project team to manage the unnecessary changes during the project. Design Changes usually occur at any stage of a project due various causes from different sources and have considerable impacts (Motawa, Anumba, Lee, & Peña-Mora, 2007). According to Yap and Skitmore (2018) lack of coordination among design consultants led to major design-related changes which affected all the design firms involved. Furthermore, setting out errors, due to poor communication and coordination between the main contractor and subcontractors and the lack of skills on the part of the artisans, were identified. Similarly, the analysis of the research instrument found that the most predominant source of rework included non-compliance with specification, setting out errors, changes made at the request of the client, poor communication with design consultants and low labor skill levels.

- **Owners Fail to Review Documents at the Right Time**

The third major cause identified in this research is owner's fail to review document at the right time. Lack of reviewing project documents before tender; make sure all detail design considerations are included and failer to follow strict procedure in review and approval of design.

- **Incorrect/Unclear Information Given by the Owner at Initial Stage of Design**

The fourth major cause identified in this research is Incorrect/Unclear Information Given by the Owner at initial stage of design. Owner's inability to provide a clear and comprehensive design brief at an early stage will later cause design changes, addition and omission of works. Iliyas et al., (2016), revealed Incorrect/Unclear Information Given by the Owner at Initial Stage of Design as main factors for design change.

- **Lack of precise and rapid decision**

The fourth major cause identified in this research is lack of precise and rapid decision during design change, design review, document review, etc.

4.4.2 Major Impacts of Design Change

Similar to that of the causes the five most important identified effects includes increase in project cost, delay of the project, demolition and rework, decrease in quality and wastage of material. These effects will be briefly discussed in the following paragraphs;

▪ Increase in Project Cost

One of the major impacts which ranked first is increase in project cost. The finding agrees with the findings of many other researchers such as Shehu et al. (2014), Chang (2002), Iliyas et al., (2016) and Burati et al., (1992). All these authors concluded increase in project cost as the first most important effects of design change in their studies. According to Burati et al., (1992) found that design and construction produced the greatest deviation of construction costs. They suggested that the deviation caused by design changes was 78% of the total deviation, 79% of the deviation of costs and 9.5% of total construction cost. They also found that two third deviations are caused by a design change. Yap and Skitmore (2017). Conducted a questionnaire survey to establish cost overrun due to design changes and concluded that cost overrun ranges between 5 – 20% of the overall project cost in Malaysia. Cox et al. (1999), analyzed four successfully executed building projects in the United Kingdom to establish the cost overrun associated with a design change. They established the cost overrun to be between 5 and 8%. However, Chang (2002) and Hwang et al. (2009) computed the cost overrun as 24% and 5% respectively due to design changes on projects evaluated in United States America (USA).

▪ Delay of Project

In agreement with (Assaf & Al-Hejji, 2006; Kaming et al., 1997), (Iliyas et al., 2016), Memon et al. (2014) the second major impact of design change identified in this research is delay of project. According to Memon et al. (2014) divided the causes of delay into two broad categories: excusable delays and non-excusable delays. Excusable delays were more orientated to the client or consultant causes, while the non-excusable delays were related to the contractor. Design change in particular was defined as a cause in excusable delays.

▪ Demolition and Rework

In agreement with previous studies the third major impact of design change identified in this research is demolition and rework. Previous studies have indicated that significant rework in construction is due to design changes (Love et al., 1999; Love, Mandal, Smith, &

Georgiou,2000; Love, Edwards, &Irani, 2008; Sommerville, 2007).Also, a study by Burati et al. (1992) revealedthat 79% of rework costs arising in industrial engineering projects were the result of designchanges, errors and omissions.The State of the South African Construction Industry's report compiled in June 2011 revealed that the gross fixed capital formation in non-residential buildings in South Africa in 2010 amounted to R41 928m which constitutes 2.3% of gross domestic product (GDP). Based upon prior research undertaken and among general contractors in South Africa which determined that rework constituted on average, 13% of the value of completed construction.

As stated by Hwang et al. (2009) , almost \$75 billion was wasted on direct cost asa result of rework in 2004 alone, thereby imposing a heavy burden on the construction industry in the USA.In another research conducted in Singapore on the analysis ofdata collected from 381 projects, the average cost overrun was determined to be 7.1%. Design change-induced rework can account for nearly 50% of cost overruns.(Love, 2002). Schedule delay from reworking is due to lower productivity because of loss of work rhythm and lower workforce morale when a completed section of work entails further dismantling and reinstallation.

- **Decrease in quality**

The fifth major impact of design change identified in this research is decrease in quality. As it is mention on above, one of the impacts of design change is demolition and rework which leads to decrease in quality of work.

- **Wastage of material**

The fifth major impact of design change identified in this research is Wastage of material. According to (Iliyas et al., 2016) some changes of the design during construction are associated to the wastage of materials. This will happen in situations where design changes require some areas of the already constructed elements of the building structure to be demolished.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This section presents conclusions, limitation of the study and recommendation. Results have been discussed in line with the research objectives stated earlier in Chapter one. This section concludes by suggesting general recommendation to prevent/minimize design changes in the construction Project.

5.1 Conclusions

As it is clearly stated in the first chapter one of the main objectives of this research were to identify major causes and impacts of design change in Airport expansion projects which is followed by identification of which contracting party is more responsible in initiating most of these design changes and which party is more affected by each of these causes. To achieve these objectives, the study use questionnaire survey and reviewed major project document. Mean score methods of analysis used to find out the result through the analysis. The result obtained in this processes has been presented and discussed in the previous chapter. In this chapter the major finding of the research which has been discussed before will be briefly summarized in accordance with the objectives of the research.

The first step in this research was to check whether design change exists and it is a problem in Airport expansion projects as well as the Ethiopian construction industry. To answer this question, data was gathered from professionals involved in Airport expansion projects; they were asked to expresses their opinion on whether design change is a problem or not in Airport expansion projects as well as in Ethiopian construction industry. The result (data) obtained from the respondents revealed design change as one of the major problems in airport expansion projects and this is also an indication that it is a problem in Ethiopian construction industry too.

- **Design change exists and it is a problem in Airport expansion projects as well as the Ethiopian construction industry.**

The first specific objective of the research was to identify the major causes and impacts of design change. To achieve this, 32 variables (potential causes of design change) were identify from literature and respondent were then requested to rate these factors based on their experience in

terms of their frequency of occurrences. The result showed that, Change requested by the owner, poor communication between responsible parties, owners fail to review document at the right time, incorrect/unclear information given by the owner at initial stage of design and lack of precise and rapid decision are the five top most significant causes of design change in Airport Expansion projects. Design changes are inevitable in any construction project. However, frequent design changes during construction stages are main reason for schedule delays and cost overruns worldwide.

- **The major causes of design change identified in this research are Change requested by the owner, poor communication between responsible parties, owners fail to review document at the right time, incorrect/unclear information given by the owner at initial stage of design and lack of precise and rapid decision.**

The second specific objective of this research was aimed to identify initiators of these causes and most affected parties as a result of design change. To achieve this, the research tries to summarize the results on identification of parties who is more responsible in causing most of the design change issues. In this regard, 12.3% of the respondent said contractor is responsible in initiating most of the design changes, 21% said Managing Consultant and majority of the respondent (66.7%) said client/owner is more responsible in initiating most of the design changes. Similarly, the survey result on most affected parties was summarized in the same manner and the result indicated that, 54% of the respondent indicated that client is most affected and the remaining 32% said contractors and 12% said design firms are most affected.

In Indonesia, Yana, Rusdhi, and Wibowo(2015) grouped the influential factors of design changes under internal and external factors. Using a questionnaire survey, they further analyzed the data using partial least squares (PLS) to reveal that the client was the main responsible party inducing design changes, followed by professional consultants.

- **Based on the survey result client are more responsible in initiating majority of the specified causes of design change and it is also the most affected party as a result of their impact.**

The third specific objective of this research was aimed to identify the major impacts of design change in Airport Expansion projects. The result revealed that, delay of project, increase in

project cost, demolition & rework, decrease in quality of work and wastage of material respectively are the major impacts of design change in airport expansion projects.

- **The major impacts of design change identified in this research are increase in project cost, delay of project, demolition and rework, decrease in quality of work and wastage of material.**

5.2 Recommendations

In general, the researcher recommends for future researchers to focus on design change management in order to minimize the impacts. Based on the above research findings and conclusion, the researcher forwarded the following recommendations;

For Consultant/design firms: -

- Effectively communicate with responsible parties to collaborate and develop the cohesive project environment in management decision-making.
- Learn from past projects to increase the competency of project managers which enhanced expert judgment.
- Advise clients at early stages, of any potential impacts that may result from each proposed design change aiming to reduce the design changes.
- Develop a complete design management approach by involving the owner and contractor at the design stages in a collaborative manner.
- Involve experienced professionals in design process.
- Assign adequate time to implement clients' ideas properly and finalize the requirements of the proposed work at the initial stage of design.
- Assign enough time and funds for feasibility studies, site investigations, detailing the existing site conditions at the initial stage of planning.
- Setting up proper method of coordination.

Clients:-

- Providing a clear and complete design brief at an early stage.
- Engage an experienced coordinator/project director to represent the client in order to ease the design process and communication with the design members.

- Through review of contract documents with reference to drawings in order to eliminate/reduce the discrepancy and deficiency between the documents
- Provide rapid and precise decision making during design change.

Contractors:-

- Active involvement during the planning/design phase can make the communication process veryproductive and minimize design changes in the future.

5.3 Limitation of the study

Limitations the researcher had encountered while undertaking this study is like,Unwillingness of the respondent to fill the questionnaire, delay in returning back the questionnaire, shortage of time and budget to undertake the study. To handle these problems, the researcher has used maximum effort through spending more time and giving more attention.

REFERENCES

- Aiyetan, A., Smallwood, J., & Shakantu, W. (2011). A systems thinking approach to eliminate delays on building construction projects in South Africa. *Acta Structilia*, 19–39.
- Alaghbari, W., Kadir, M. R. A., Salim, A., & Ernawati. (2007). The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management*, 14(2), 192–206.
- Alashwal, A. M., & Fong, P. S.-W. (2015). Empirical study to determine fragmentation of construction projects. *Journal of Construction Engineering and Management*, 141(7), 4015016.
- Alison, N. (2008), Understanding the Architects Design Phases. Blue Sky Architecture P.C Colorado USA.
- Anantatmula, V. S. (2015). Strategies for enhancing project performance. *Journal of Management in Engineering*, 31(6), 4015013.
- Andi, & Minato, T. (2003). Representing causal mechanism of defective designs: A system approach considering human errors. *Construction Management and Economics*, 21(3), 297–305.
- ARCOM Conference, 6-8 September 2010, Leeds, UK, Association of Researchers in Construction Management, 21-29.
- Chang, A. S. T. (2002). Reasons for cost and schedule increase for engineering design projects. *Journal of Management in Engineering*, 18(1), 29–36
- Chang, A. S. T., Shih, J. S., & Choo, Y. S. (2011). Reasons and costs for design change during production. *Journal of Engineering Design*, 22(4), 275–289.
- Doloi, H., Sawhney, A., Iyer, K. C., & Rentala, S. (2012). Analysing factors affecting delays in Indian construction projects. *International Journal of Project Management*, 30(4), 479–489.
- E. Ng, “No cost overrun for klia2, says Liow,” The Edge Markets, 19 May (2015).
- Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of Project Management*, 21(5), 321–326.
- Gharaee M., (2012), Change Management and Change Process Model for the Iranian Construction Industry, *A Journal of Management. Bus. Res.*, 2 (2), 85- 94.
- González, P., & González, V. (2014). Analysis of causes of delay and time performance in construction projects. *Journal of Construction Engineering and Management*, 140(1), 1–9.

- Jonathan T. and Frederick S. (2001) *Building Design and Construction Handbook*, 6th Ed, McGraw-Hill, Two Penn Plaza, New York, Ny 10121-2298.
- Hamzah, N., Khoiry, M. A., Arshad, I., Badaruzzaman, W. H. W., & Tawil, N. M. (2012). Identification of the causes of construction delay in Malaysia. *World Academy of Science, Engineering and Technology*, 72(12), 312–317.
- Han, S., Love, P., & Peña-Mora, F. (2013). A system dynamics model for assessing the impacts of design errors in construction projects. *Mathematical and Computer Modelling*, 57(9–10), 2044–2053.
- Hindmarch, H., Gale, A. W. and Harrison, R. E. (2010) A proposed construction design change management tool to aid in making informed design decisions. In: Egbu, C. (Ed) *Procs 26th Annual*.
- Hsieh, T. Y., Lu, S. T., & Wu, C. H. (2004). Statistical analysis of causes for change orders in metropolitan public works. *International Journal of Project Management*, 22(8), 679–686.
- Hwang, B. G., Zhao, X., & Goh, K. J. (2014). Investigating the client-related rework in building projects: The case of Singapore. *International Journal of Project Management*, 32(4), 698–708.
- Josephson, P.-E., Larsson, B., & Li, H. (2002). Illustrative Benchmarking Rework and Rework Costs in Swedish Construction Industry. *Journal of Management in Engineering*, 18(2), 76–83.
- Kathryn, E. and Harvey, M. (2014). *Managing Uncertainty and Expectations in Building Design and Construction*. Bedford, 1-800-591-4462.
- Kikwasi, G.J. (2012) 'Causes and Effects of Delays and Disruptions in Construction Projects in Tanzania', *Australasian Journal of Construction Economics and Building*, Conference Series, 1 (2) 52-59.
- Koskela, L., Huovila, P., & Leinonen, J. (2002). Design management in building construction: from theory to practice. *Journal of Construction Research*, 3(1), 1.
- Laufer, A., Shapira, A., & Telem, D. (2008). Communicating in dynamic conditions: how do on-site construction project managers do it? *Journal of Management in Engineering*, 24(2), 75–86.
- Love, P. E. D. (2002). Influence of project type and procurement method on rework costs in building construction projects. *Journal of Construction Engineering and Management*, 128(1), 18–29.
- Love, P. E. D., & Edwards, D. J. (2004). Determinants of rework in building construction projects. *Engineering, Construction and Architectural Management*, 11(4), 259–274.
- L. Ruddock, *Economics for the Modern Built Environment*, USA: Taylor & Francis, 2009.

- Mehta, M. & Scarborough, W. & A. D., (2009). *Building Construction; Principles, Materials, and Systems*. New Jersey: Prentice Hall.
- Mohamad, M., Nekooie, M., & Al-Harthy, A. (2012). Design changes in residential reinforced concrete buildings: The causes, sources, impacts and preventive measures. *Journal of Construction in Developing Countries*, 17(2), 23–44.
- Olawale, Y., “*Cost and time control practice of construction project in the UK*”, University of the West of England, (2010).
- Project Management Institute. (2013). *A guide to the project management body of knowledge (PMBOK Guide)* (5th ed.). Pennsylvania, USA: Project Management Institute, Inc.
- R. Ghazali, “Transport Ministry: KLIA2 construction never experienced cost overruns,” *The Star Online*, 19 May (2015).
- Sambasivan, M., & Yau, S. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, 25(5), 517–526.
- Scott, J. (2008), *Traditional Design and Construction Phases*. Courtesy of US Builders Review. Washington.
- Senaratne, S., & Ruwanpura, M. (2016). Communication in construction: A management perspective through case studies in Sri Lanka. *Architectural Engineering and Design Management*, 12(1), 3–18.
- Sun, M., & Meng, X. (2009). Taxonomy for change causes and effects in construction projects. *International Journal of Project Management*, 27(6), 560–572.
- Thyssen, M. H., Emmitt, S., Bonke, S., & Kirk-Christoffersen, A. (2010). Facilitating client value creation in the conceptual design phase of construction projects: A workshop approach. *Architectural Engineering and Design Management*, 6(1), 18–30.
- Werku Koshe, K. N. Jha. Investigating Causes of Construction Delay in Ethiopian Construction Industries. *Journal of Civil, Construction and Environmental Engineering*. Vol. 1, No. 1, 2016, pp. 18-29.
- Wu, C. H., Hsieh, T. Y., & Cheng, W. L. (2005). Statistical analysis of causes for design change in highway construction on Taiwan. *International Journal of Project Management*, 23(7), 554–563.

APPENDIX: RESEARCH QUESTIONNAIRE

St. Mary University
School of Graduates Studies
Masters of Project Management (MBA)

Dear Participants,

As part of my MA in project management program, I am currently undertaking a case study which aims at **Assessing Major Causes and Impacts of Design Change in Bole International Airport Expansion Projects.**

With sincerity I would like to extend my deep appreciation to your company and the staff for the willingness and cooperation in undertaking this valuable research. I ask your kindly cooperation in answering the questions as truthfully as possible. Your response will be highly confidential and this survey will only be used for a student research purposes only.

The objective of this research is to identify major causes of design changes and their impacts in Airport Expansion projects and to recommend possible remedial measures that minimize design changes. For the purpose of this research design change is defined as any change in the design or construction of a project after the contract is awarded and signed. These changes are any additions, omissions or adjustments made to the original scope of work after a contract is awarded. Your open and prompt response is highly essential to fulfill the objective of this research and to address the problem. For any further information the researcher can be reached through **Mobile: 09-13-177452, Email: fregeneted@gmail.com**.

Yours Sincerely

Fregenet Zemedkun

November, 2019.

Part 1: Company and Respondent Profile

1.1 Please provide the following information about your professional and organizational profile by marking (X) under your choice.

Gender	Male		Age	Your work experience (in years)			Type of company you are working for	Your company experience (in years)		
	Female			In the construction industry	In Airport Expansion Projects			In the construction industry	In Airport Expansion Projects	
Citizenship	Ethiopian		25 - 30	0 - 5	0 - 5		Client/owner	0 - 5	0 - 5	
	Foreigner									
Educational level	1 st Degree		36 - 40	11-15	11-15		Consultant	11-15	11-15	
	2 nd Degree		41 - 45	16-20	16-20		Local contractor	16-20	16-20	
	PHD		46 - 50	21-25	21-25		Foreign contractor	21-25	21-25	
Occupational level	Managerial		> 50	> 25	> 25		Other specify	> 25	> 25	
	Non-managerial									
	Other specify									

1.2 Your Academic background Your current position in the organization

Part 2: Factors Which Contributes For the Causes of Design Changes

2.1 How frequent is the change of design in the Airport Expansion Project?

- No change made so far A few numbers of times Many times/frequently

2.2 Design change is a problem in Ethiopian construction industry in general and that of Airport Expansion projects in particular?

- Agree Strongly Agree Disagree Strongly Disagree

2.3 If your answer is agree/strongly agree for question 2.2, Based on your experience in Airport Expansion Projects that you have involved, please rate your answer by marking (X) under your choice on the table below.

Major Causes of Design Changes		Rate of Occurrence					Main Initiators					Most affected party/parties				
		No occurrence (0)	Low occurrence (1)	Medium occurrence (2)	High occurrence (3)	Very High occurrence (4)	Client / Owner	Design Firm	Managing Consultants	Contractors	Others / third parties	Client / Owner	Design Firm	Managing Consultants	Contractors	Others /third parties
For Illustration	Factor 1	X							X				X		X	
	Factor 2		X				X						X			
	Factor 3				X					X						
1. Client - related (Internal factors)																
1.1 Changes requested by the owner																
1.2 Owner's change of schedule due to financial Problem																
1.3 Owner fails to review document at the right Time																
1.4 Incorrect/unclear information given at initial stage of design																
1.5 Obstinate nature of client (not considering others constructive idea)																
1.6 factor related to corruption																
2. Design - related (Internal factors)																
2.1 The unrealistic period to design																
2.2 Inadequate information in the tender documents; errors and omission.																
2.3 conflicts between contract document (drawing Vs specification)																
2.4 poor design quality, design error																
2.5 poor communication among design Team & with client																
2.6 Lack of knowledge available resources																
2.7 lack of geotechnical investigation																
3. Managing consultant-related (Internal factors)																
3.1 poor communication of responsible parties																
3.2 The changes requested by the consultant																
3.3 Lack of precise and rapid decisions																

Major Causes of Design Changes	Rate of Occurrence					Main Initiators					Most affected party/parties				
	No occurrence (0)	Low occurrence (1)	Medium occurrence (2)	High occurrence (3)	Very High occurrence (4)	Client / Owner	Design Firm	Managing Consultants	Contractors	Others / third parties	Client / Owner	Design Firm	Managing Consultants	Contractors	Others /third parties
4. Contractor – related (Internal factors)															
3.1 The unrealistic construction’s schedule															
3.2 The changes initiated by contractors															
3.3 Rectify construction mistakes															
3.4 Poor site/project management skill															
3.5 Lack of contractor’s involvement in design															
5. Site - related (Internal factors)															
5.1 unforeseen underground condition															
6. political and economic factors (External factors)															
6.1 The changes in policies and regulations															
6.2 Inflation and price fluctuation															
6.3 Unavailability/shortage of materials															
6.4 Change of market demand															
7. environmental factors (External factors)															
7.1 Changes of weather conditions															
7.2 Occurrence of natural disaster such as, flood ,earthquake, etc.															
7.3 Insufficient information on geological conditions															
8. third parties factors (External factors)															
8.1 The request made by end user															
8.2 The request from regulatory bodies															
8.3 The request from investor who came while construction has Started															

Part 3: Major Impacts of Design Changes and Possible Measures to Be Taken To Minimize It.

3.1 Based on your experience, please rate the degree of impact of the following statements on the Airport Expansion Projects you have Been involved by marking (X) under your choice.

Major Impacts	Degree of Impact				
	No Impact	Low Impact	Medium Impact	High Impact	Very High Impact
1. Increase in project costs (cost overrun)					
2. Delay of the project (time overrun)					
3. Decrease in quality of work					
4. Decrease in productivity					
5. Demolition and Rework					
6. Wastage of materials					
7. Damage firm reputation					
8. Results dispute among parties					

3.2 Please forward possible measures to be taken to minimize design changes and its impact.

.....

.....

.....

.....

.....

3.3 please write your overall comment on the subject design change.

.....

.....

.....

.....

.....

Thank you very much for your cooperation

Declaration

I, **Fregenet Zemedkun**, have carried out independently a research work on Assessing Major Causes and Impacts of Design Change in the case of Bole International Airport Expansion Projects for partial fulfillment of the requirement of the MBA program in project Management with the guidance and support of the research advisor. This study is my original work and that has not been presented for any degree or diploma program in this or any other university/institutions, and that all source of materials used for the thesis have been properly acknowledged.

Declared by: **Fregenet Zemedkun**

Signature: _____

Date: _____

ENDORSEMENT

This is to certify that Fregenet Zemedkun has carried out her research work on the topic titled **“Assessing Major Causes and Impacts of Design Change: The Case of Bole International Airport Expansion Projects”**. The work is original in nature and is suitable for submission for the reward of the M.A Degree in Project Management.

Supervisor: Tilaye Kassahun(PhD)

Signature -----

Date-----

